CRITICAL ANGLE OF REPOSE OF MARTIAN DUST. L. E. Möller, Moscow Junior High School, 215 North Van Buren St., Moscow, ID 83843, lucasm@moscow.com.

Introduction: In the exploration of Mars, wind-blown dust will be a considerable challenge. The long-term environmental compatibility of solar cells, instruments, and materials will require design and fabrication to ensure resistance to failure [1]. Understanding the angle of repose of Martian dust and its avalanche behavior is important in this design process. For example, solar arrays during the Pathfinder mission showed a 0.3% loss per day [2]. Airborne particles that deposit on surfaces will interact with the surface and with other particles by several physical forces. The critical angle of repose defines the angle of the surface where the slope force of Martian gravity exceeds the static friction holding dust to a surface.

This work describes an instrument and experiments in the Mars Environmental Compatibility Assessment (MECA) experiment bay of the canceled NASA Mars Surveyor 2001 Lander Mission and related laboratory experiments [3]. This project was selected, fabricated, and flight-tested in the Student Nano-Experiment Challenge by The Planetary Society and NASA-JPL.

Experimental Approach: Circular surfaces, such as cylinders and spheres, have a full range of tangent angles for a simple measurement of the angle at which deposited dust will no longer adhere. A solid 1 cm x 1 cm aluminum cylinder was machined to present concentric cylindrical surfaces at the 52º open angle of the MECA experiment bay (Figure 1).
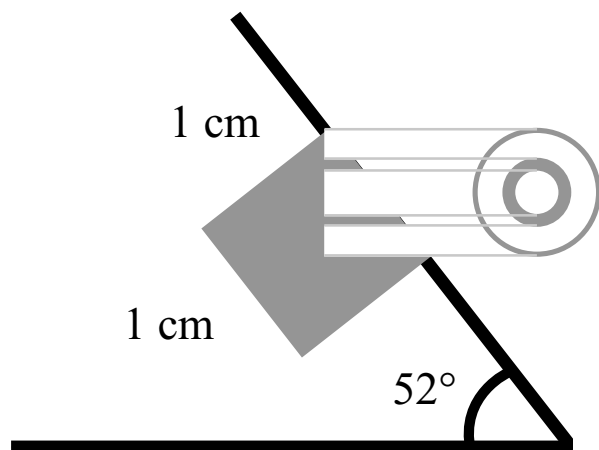

Figure 1. Critical angle instrument.

The design allows for six points of dust angle measurements on the inner and outer cylindrical surfaces. Dust collection over the mission term is expected to adhere only to surfaces with less than the critical angle of repose. The lander robotic arm camera would take high-resolution images for graphical analysis. The instrument was successfully flight tested and incorporated into the MECA test bay.

Laboratory experiments. The critical angle measurement instrument was tested with Martian Regolith Simulant JSC Mars-1 and Lunar Regolith Simulant JSC-1 [4, 5]. Although windblown Martian dust is estimated to have a radius of < 2 μm, the simulants were sieved at < 75 μm with this fraction used in all tests [6]. The simulants were placed in stacked 150 μm and 75 μm sieves and agitated 0.5 m above and 0.5 m to the side of the critical angle instrument. A small laboratory air draft carried the airborne dust fraction to the instrument below. Images of the instrument after dust collection were obtained using a 2.1 Mpixel digital camera and analyzed graphically. Critical angles were measured for the left (L) and right (R) sides of the convex, upper (U) concave and lower (L) concave zones of the instrument.

Results: Tables 1 and 2 show the results for three tests with each of the simulants. The total average critical angle for all tests was 44º ± 8º for the Mars simulant and 42º ± 8º for the Lunar simulant.

	L1	R1	L2	R2	L3	R3	**AVG**	**SD**
Convex	28.5	33.5	35.0	43.5	29.0	34.5	**34.0º**	**5.4º**
Concave U	63.0	64.5	54.0	44.0	41.5	57.0	**54.0º**	**9.6º**
Concave L	57.0	54.5	50.5	48.5	54.5	54.5	**53.3º**	**9.6º**

Table 1. Martian Regolith Simulant JSC Mars-1 critical angle measurement data.

	L1	R1	L2	R2	L3	R3	**AVG**	**SD**
Convex	18.5	34.5	32.5	34.0	33.0	45.0	**32.9º**	**8.5º**
Concave U	58.5	44.0	41.0	43.0	54.5	54.5	**49.3º**	**7.4º**
Concave L	49.0	72.0	52.0	52.5	54.0	44.5	**54.0º**	**9.4º**

Table 2. Lunar Regolith Simulant JSC-1 critical angle measurement data.

Conclusions: Convex surfaces minimize critical angles while concave surfaces maximize them, probably due to particle interaction. Since the gravity of Mars is 37.7% of Earth's, this may play a role in dust behavior, however the physical properties of Martian dust are expected to dominate smooth surface activity.

References: [1] Landis, G. A. and P. Jenkins. (1998) http://powerweb.lerc.nasa.gov/pvsee/publications/wcpec2/DART.html (May 1999). [2] Landis, G. A. and P. Jenkins (1997) *Proc. 26th IEEE Photovoltaic Spec. Conf.,* Vol 2, pp 865-869. [3] Mars Environmental Compatibility Assessment (MECA) http://mars.jpl.nasa.gov/2001/lander/meca/ (Jan. 2001) [4] Allen C. C. et al. (1998) *LPS XXIX*. [5] McKay D. S. et al. (1996) *LPS XXIV*. [6] Pollack, J. B. et al. (1995) *JGR* 100, 5235.